"Assessment of Research and Development Efforts Supporting Future Operational Concepts for the National Airspace System"

NASA RTO-23: NAS2-98005

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1 INTRODUCTION

1.1 OBJECTIVE

This is the report of the results for National Aeronautics and Space Administration (NASA) contract NAS2-98005 RTO-23, "Assessment of Research and Development Efforts Supporting Future Operational Concepts for the National Airspace System." The objective of this study was to map the “Air Traffic Services Concept of Operations for the NAS in 2005-Narrative” [1] (Narrative) with research and development programs, and find the gaps in research being done to satisfy the stated content of the Narrative.

1.2 BACKGROUND

The predecessor to this program was RTO-2 "Global Gap Analysis of Operational Requirements Derived from Future Operational Concepts for the National Airspace" which was completed in November 1998. That delivery included 6,000 mapped relationships between 120 programs and the Narrative. RTO-23 was defined to increase the scope or research and development programs evaluated and produce a final report.

1.3 PROGRAM OVERVIEW

This work concentrates on the research and development being performed in the United States that is relevant to the Narrative. The CIP was brought into the analysis to include currently funded FAA development programs. The final judgement of research and development gaps includes consideration of 405 Eurocontrol programs, the FAA's Architecture Version 4.0, work solicited under NAS2-98005, work described in RTCA documents, and other supporting work and programs.

The analysis was expanded to include the Federal Aviation Administration’s (FAA) "Capitol Investment Plan for 1999" [2] (CIP). The CIP, together with the research and development programs, provides a collective view of the work being performed to meet the future vision provided by the Narrative.

RTO-23 called for six tasks and four Contract Deliverable Requirements Lists (CDRL):

- Task 1: Include MITRE Center for Advanced Aviation System Development (CAASD) 1999 research

  The information is included in the analysis. Summaries of the programs are found in 0.

- Task 2: Include Eurocontrol material

  The information is included in the final phase of analysis. Summaries of the programs are found in 0.

- Task 3: Identify and explore additional research resources

  The analysis expanded to include NOAA, NCAR, NEXTOR, NASA TAP, Lincoln Laboratory, and FAA CIP.

- Task 4: Determine minimum level of detail necessary

  The format of the program summaries (0) includes the identified minimum level of detail.

- Task 5: Review the categorization processes and ensure that programs or projects not materially contributing to NAS are so identified

  Programs were individually examined to determine the types of output. Programs not materially contributing to the NAS were removed from the study.

- Task 6: Develop a methodology to conduct subject matter expert reviews and accomplish the review

  The developed methodology is described in section 2 .

- CDRL #1: Task Plan

- CDRL #2: Weekly Telephone Status Reports

- CDRL #3: Monthly progress Reports

- CDRL #4: Final report

The CDRL #1 through #3 were completed on schedule. This report is CDRL #4 and embodies all of the work completed on Tasks 1 through 6 together with the methodology and combined results from RTO-2. It provides an accumulation of research and development program data, an analysis methodology, analysis and mappings of the data, and assessments of gaps in research.

The material is provided both in hard copy and on a CD-ROM. The CD-ROM version of the document includes the collection of all programs used in the analysis, the primary materials developed to perform the analysis, and hyperlinks between documents as is appropriate.

1.4 REPORT ORGANIZATION

The printed version of this report consists of sections

1. Introduction
2. Analysis Methodology

   The section described the methods used in collecting, preparing, and analyzing the data from the programs and the Narrative Level I CONOPS entries.
3. Analysis Results

   The results of the analysis are provided in this section. These results include identification of gaps and statistical summaries of the data.
4. Conclusions

This section identifies the conclusions that were drawn from the analysis results and the experience gained from the process.

5. Recommendations

Appendices:

Appendix A:	Acronyms and Abbreviations
Appendix B:	Definitions
Appendix C:	Listing of All Documents Used in the Analysis
Appendix D:	Level 1 Concept of Operations and Categorization
Appendix E:	Research and Development Program Summaries
Appendix F:	Mapping of Programs to Level 1 CONOPS

Sections 1 through 6 and Appendices A, B, and C are in Volume I of the document. Appendices D and E are in Volume II of the document. Appendix F is Volume III and only one printed copy of the material is delivered because of its size.

The CD-ROM version of this deliverable includes the report, all of the appendices, electronic copies of the documents used in the analysis, and hyperlink connections between the documents and analysis as is appropriate.

Included on the CD-ROM is a file named "Readme.doc" which explains the content of the CD-ROM and how to use it. All of the material developed under contract is either in Microsoft Word 97 or Excel 97. Other supporting information and documents are in their native form that may additionally include HyperText Marking Language (HTML), Adobe PDF, text, or Word Perfect.

2 ANALYSIS METHODOLOGY

2.1 DATA ANALYSIS METHODS

0 describes the analysis methodology. This process consists of ten steps in three phases:

PHASE I - INITIAL ANALYSIS (Steps 1 through 7)

Steps one, two and three (the left upper branch in 0) include the preparation and categorization of the Level I CONOPS entries. Preparation of the Level I CONOPS entries consisted of identifying and listing passages in the Narrative that created constraints in the future air traffic environment. Categorization of the Level I CONOPS entries consisted of determining what “functions” were affected by the CONOPS entries. The functions included communications, navigation, surveillance, weather, automation, maintenance/facilities, and human factors. Steps one, two, and three were carried forward from the work done during RTO-2. Steps four and five are the collection and categorization of ongoing programs that support the future NAS environment. In the Mapping (step six), these two branches are combined by developing a relationship, or mapping, between the programs and Level I CONOPS entries. The categorization results were central to this step. The development of the list of gaps is step seven. The Narrative creates constraints on the capabilities of the future air traffic system. Gaps are the set of constraints that are not being addressed by the programs collected in steps four and five. For example, the Narrative describes capacity control programs (CCP’s), but no programs in this study addressed that issue. A complete list of gaps is in Section 3.2.

PHASE II - SUBJECT MATTER EXPERT REVIEW (Steps 8 and 9)

The subsequent subject matter expert (SME) review phase (step eight) of these mappings provides a collection of judgements which are finally assimilated in the Gap / Overlap Analysis (step nine).

PHASE III - GAP QUALIFICATION (Step 10)

The assembled results from phases I and II are examined a final time (step ten).

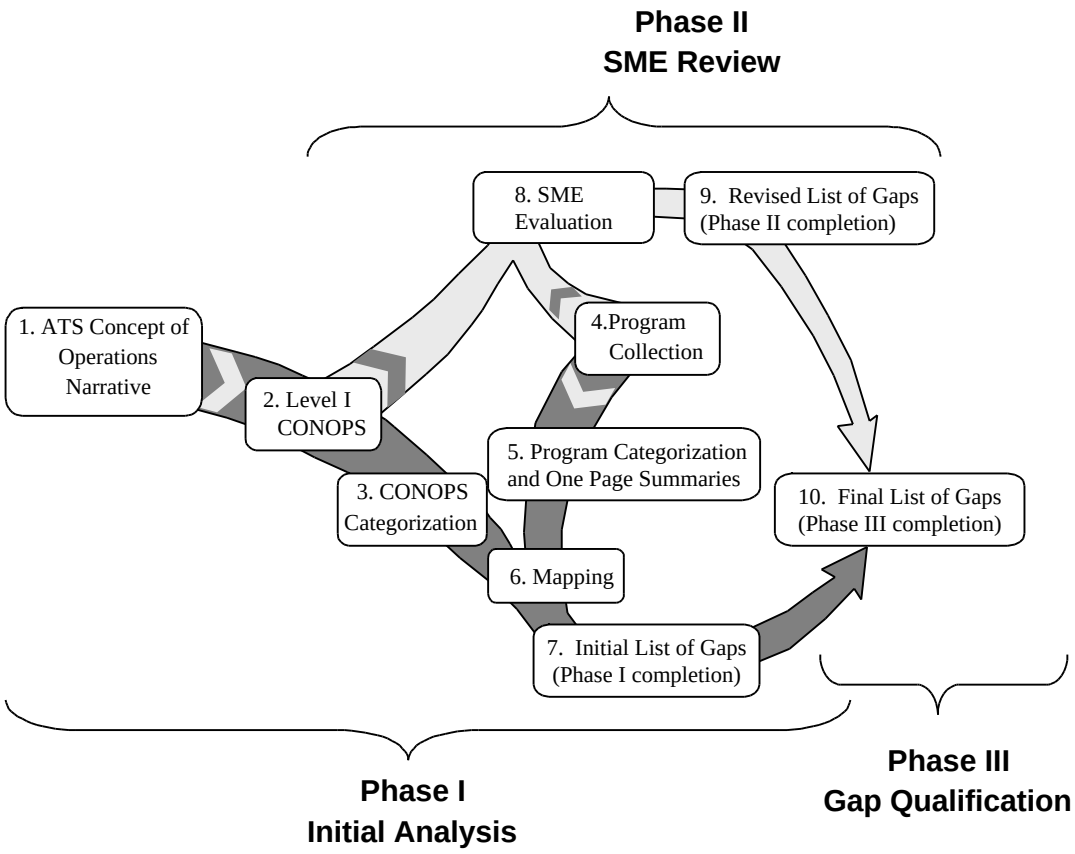


Figure 1 Gap/Overlap Analysis Flow Down

Step 1. ATS Concept of Operations Narrative: The Narrative was developed and published in September 1997 by the FAA, and is the result of a joint government and industry study of how the National Airspace System should evolve between the present status and the eventual mature stage of Free Flight.

Steps 2 and 3. Level I CONOPS and CONOPS Categorization: Verbatim phrases and sentences from the Narrative were organized into a hierarchy called the "Level I CONOPS." These CONOPS entries were categorized by domains, functions, and systems as shown in Table 1. The domains are the titles of Chapters 2 through 8 of the Narrative. Chapter 1 is the introduction to the Narrative and is not a domain. The seven functions are broad technology areas. The Systems category identified whether Ground, Airborne, or Space environments applied. The definitions of the categories are in Appendix B.

Table 1 Categorization of CONOPS and Programs is a Basis for Mapping

Functions	Domains	Systems
· Communication · Navigation · Surveillance · Weather · Automation · Maintenance and Facilities · Human Factors	· Flight Planning · Airport Surface · Departure and Arrival · En Route / Cruise · Oceanic Operations · NAS Management · Management	· Ground · Airborne · Space

Step 4. Program Collection: Program descriptions were collected from a broad collection of sources, as is summarized in Table 5. The complete collection of programs and documents incorporated in the analysis is in Appendix A. The CD-ROM version of this report includes all available soft copies of these materials and hyperlinks.

Step 5. Program Categorization and Summaries: Each program that was used in Phase I was summarized on one page to allow quick referencing during analysis. If more detailed information was necessary, the full program document could be accessed via a hyperlink on the summary. An example of a Summary is in Figure 2. The entire collection of these summaries is found in Appendix A. These summaries include a categorization of the defined program work, a reference to the program document, and other information abstracted from the program document. The categories are listed in Table 1 and complete definitions are found in Appendix B. Program categorization entailed assessments with the rating system shown in Table 2. Each program was rated based on its relevance to the categories.

The categorization of a program provides a high level description of the program's content. This high level description allowed the identification of potential relationships between programs and CONOPS entries.

Development of the summaries and the categorization data was accomplished via the following steps:

A. **The top one third of the information** (Title, Reference, Contact, Date, and Overview) was abstracted from the source. The material for the FAA Research Program Descriptions (RPD) for fiscal year 2000 was taken directly from the documents. Other sources varied. For example, the MITRE and Lincoln Laboratory Summaries were developed by the sources and finalized by the SRC team.

B. **The "Expected Output" material** consists of a brief "Description," the "IOC" (Initial Operating Capability) date, the "Final" item delivery date, and four columns describing the type of deliverable. The four columns were filled in by the source; the four columns are:

Procedures to Be Implemented: A check mark in this column indicates that the result of the work will include procedures, circulars, regulations or other official management documents.

HW or SW to Be Implemented: This delivery includes hardware or software that is ready for implementation.

Experimental: The delivery is an experiment and the resulting data, results, conclusions, and report. This delivery could include experimental hardware or software.

White Papers and Studies: The delivery is a study summarized in a white paper or report.

C. **The bottom one third of the form** was then developed. SRC filled in this categorization information initially based on the definitions in Appendix B.

Internal review by the SRC team was then performed with at least two people examining the Summary. The SRC team that reviewed this material included a senior and a mid level systems engineers, a commercially rated pilot, and a degreed aeronautical systems major with training in air traffic control and experience in airport and airline operations. The team's varied background allowed analysis from multiple points of view. The central importance of the categories necessitated this approach, which produced an unbiased and objective result.

D. **Review by the Source** was then conducted to further ensure accuracy. The Summaries from the FAA, MITRE, Lincoln Laboratory, NOAA, NCAR, and NASA TAP were all completed and the corrections and comments were installed. The NASA AATT categorizations are exactly those used in NASA task RTO-2 so this information was carried forward from RTO-2.

Research and Development Program Summary

Title:	Aeronautical Data Link	pg		of	
Reference:	rpdadl				
Contact:	Lockett K. Yee, AND-720				
Date:	20-Mar-98				

Overview:

- Increase system safety by reducing weather, atmospheric, and traffic related incidents and accidents by implementing a data link system architecture and procedures allowing the dissemination of flight information service (FIS)/weather products and traffic information to the flight deck along with the corresponding ability to receive, process, and display the information.
- Increase system safety by reducing ATM/pilot information processing and communications errors by establishing a controller-pilot data link communications (CPDLC) capability in all domestic domains. This includes the development of a system architecture, procedures, and an effective computer-human interface (CHI) that will allow a seamless information exchange between controllers and pilots in all domestic domains.

Expected Output:

						Procedures to Be Implemented	HW/SW to Be Implemented	Experimental	White Papers and Studies
Description:		FIS/Weather Cockpit Decision Aid Analysis & Datalink Implementation							X
IOC	First:	1998	Final:	2004					
Description:		Datalink Communication Alternatives Analysis							X
IOC	First:	1998	Final:	2004					
Description:		TIS Enhancements							X
IOC	First:		Final:	1999					
Description:		TIS Uplink Communications Alternatives							X
IOC	First:	1998	Final:	2001					
Description:		Decision Support System Services							X
IOC	First:	1998	Final:	2004					
Description:									
IOC	First:		Final:						

Categorization (N, Y, Y+, Y++):

Functions - (N, Y, Y+, Y++)		Domains (Paragraphs from the FAA's "ATS Concept of Operations for the NAS 2005 - Narrative" - (N, Y, Y+, Y++)	
Y++	communications	Y	2. Flight Planning
	navigation	Y	3. Airport Surface
	surveillance	Y	4. Departure/Arrival Service
Y++	weather	Y	5. En Route Cruise
Y	automation	Y	6. Oceanic Ops
	maintenance and facilities	Y++	7. NAS Management
	human factors		8. Management
Systems - (N, Y, Y+, Y++)			
Y+	ground systems		
Y	space systems		
Y++	airborne systems		

Reference:	031-110 Aeronautical Data Link (ADL) Communications;
Related Programs:	

Figure 2 Summary Example - FAA RPD For Aeronautical Data Link

Table 2 Categorization Rating Definitions

Rating	Definition
Y++	Major role of the program
Y+	Secondary role of the program
Y	Impacts category
N or "blank"	Does not impact the category

Step 6. Mapping Analysis: The mapping process is illustrated in Figure 3. This process established direct relationships from the CONOPS entries in the study to the programs that solved them. The process begins with the set of 325 categorized Level I CONOPS entries (see Appendix A) and 697 categorized programs (Appendix A). The process was streamlined to eliminate most of the non-matches by using the categorization results from steps three and five. The potential mappings are the collection of Level I CONOPS entries and program pairs for which domains and functions match.

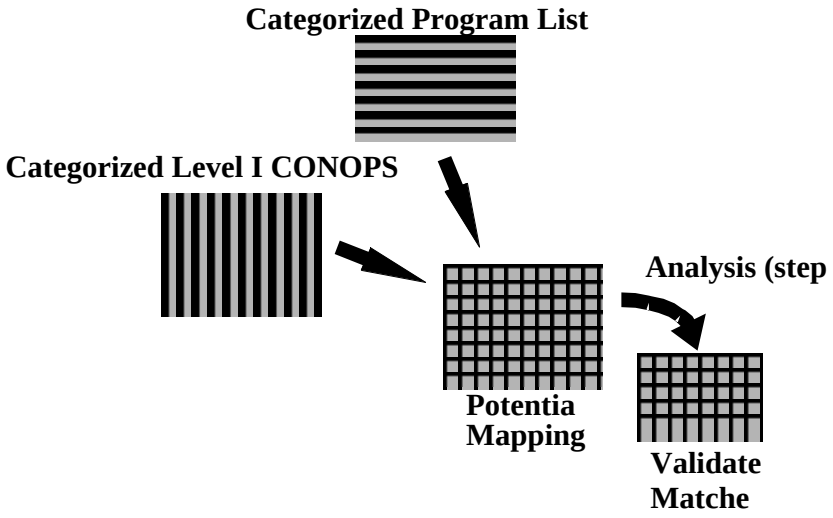


Figure 3 Program to Level I CONOPS Matching Process

As an example, in Table 3, CONOPS Entry Y matches Program X in one function, Communication, and one domain, Airport Surface. Therefore, Program X is identified as a potential mapping to CONOPS Entry Y, and will be examined more closely by an analyst. In this way, all potential program-to-CONOPS-entry mappings are identified, and many non-mappings can be eliminated. The categorization ratings are defined in Table 2.

Table 3 Categorization Matching Example

	Categories	*CONOP Y*	*Program X*	
Functions	Communication	Y	Y	**function match**
	Navigation			
	Surveillance	Y		
	Weather	Y		
	Automation		Y	
	Maintenance & Facilities			
	Human Factors			
Domains	General	Y		
	Flight Planning			
	Airport Surface	Y+	Y	**domain match**
	Departure / Arrival	Y		
	En Route / Cruise		Y++	
	Oceanic Ops			
	NAS Management			

The mapping results are in Appendix F. The scoring system shown in Table 4 was used to identify the significance of a mapping.

Table 4 CONOPS to Programs Scoring Definitions

Rating	*Definition*
Y	YES, the program addresses the CONOPS entry.
E	EXTENSIBLE, the program could address the CONOPS entry, with modifications.
N	NO, the program does not address the CONOPS entry.

The process of scoring the pairings consisted of several detailed steps.

A. ***Create an Excel spreadsheet for each Level I CONOPS entry*** with a listing of all programs that are potentially mapped to the entry. That is, make a list of the programs that match categories with the CONOPS entry. Each program listing was hyper-linked to the corresponding Summary for the program. Additionally, each Summary was hyper-linked to the program document. The CD-ROM version of this report contains all of these hyperlinks. An example of such an Excel page is in Figure 4. A detailed description of the information on this page is contained in Appendix F.

B***. Initial scoring of each program*** with the CONOPS entry was accomplished one source at a time by the analyst. That is, all FAA RPDs were initially scored for all CONOPS entries before starting on the MITRE Programs. The analyst judged the relevance of the program work described in the original document and assigned a score of Y, E, or N as defined in Table 4.

The original collection of 300 program documents was reduced to 95 potentially mapped programs in step A for the example in Figure 4. After the scoring for this particular example was completed, the total number of maps with an “Y” was 27 and “E” was 2.

The analyst completed a seven-line assessment of coverage of each CONOPS entry by each source when the scoring was completed. An example of this coverage summary is at the top of Figure 4 under the section heading "FAA R&D Programs."

C. ***Review of the scoring*** of each program with each CONOPS entry was performed. The entire team developed and reviewed the material; the team included a commercially rated pilot, two systems engineers, and a college graduate trained in air traffic control. Differences in judgement were discussed between the team members and resolved.

D***. Finalized scoring*** of each program with each CONOPS entry was performed. Upon completion of the scoring reviews, the final results were organized by Narrative subsection. These results are found in the CD-ROM version of this document in Appendix F. The programs with a score of N have been removed.

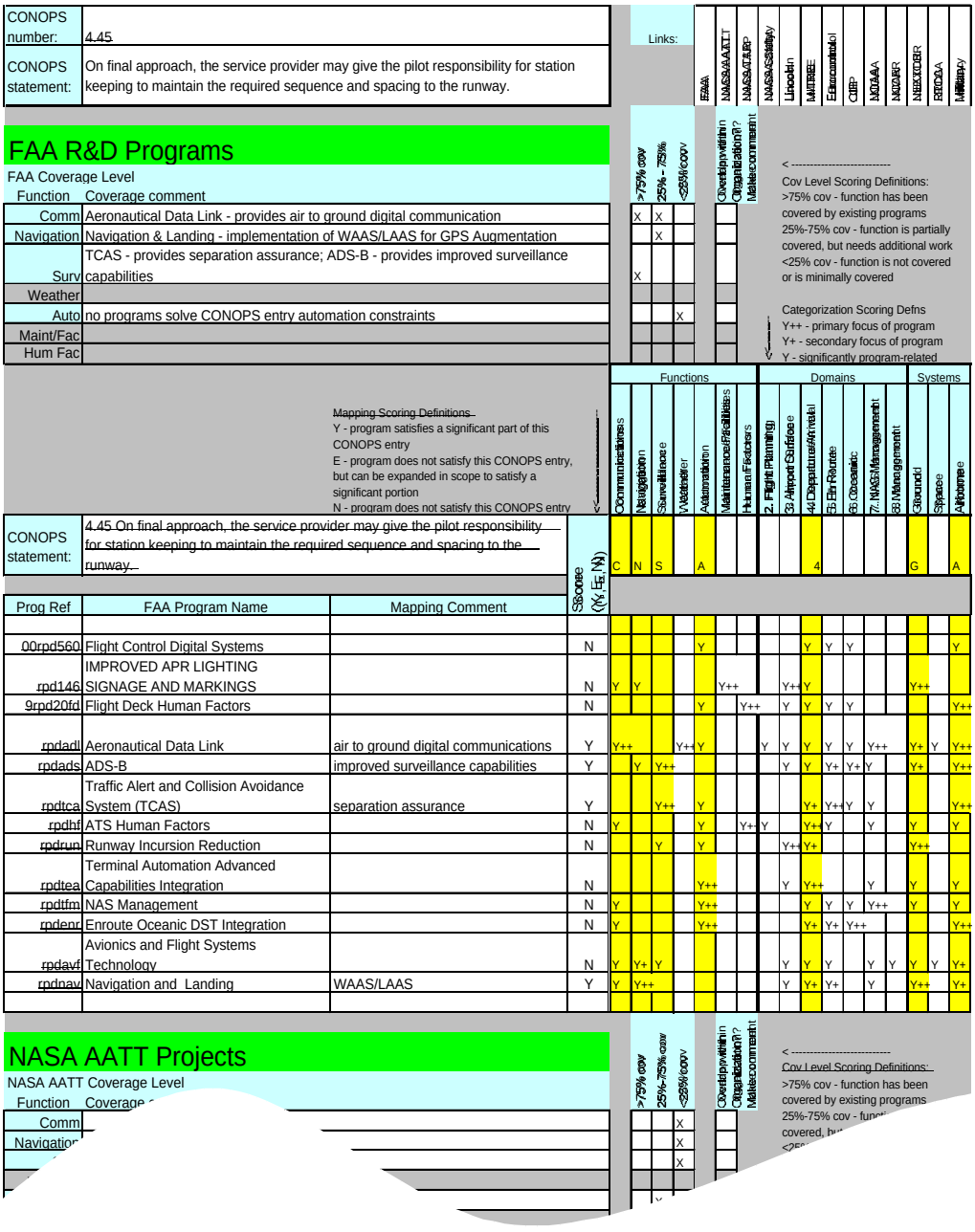


Figure 4 Scoring Page with Y, E, and N Judgements.

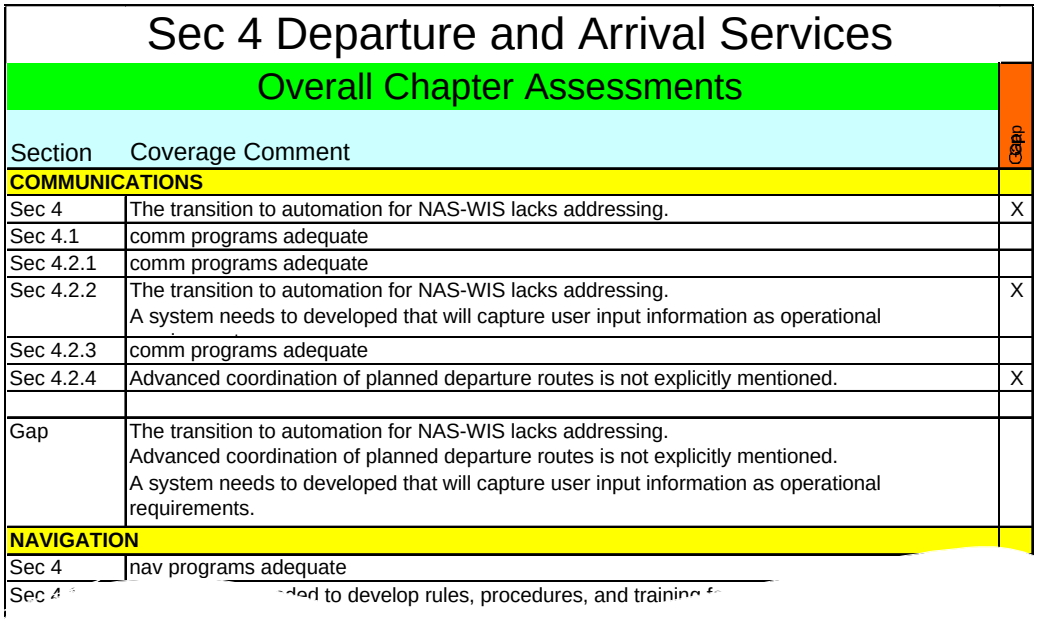
Step 7. Initial List of Gaps (Phase I complete): The process for developing a list of gaps

in Phase I consisted of a detailed examination of each CONOPS entry in the context of the Narrative. This analysis was completed for all of the CONOPS entries for all of the subsections in the Narrative Sections 2 through 7. The Narrative Section 1, "Introduction," and Section 8, "Management," were not analyzed for Gaps because the significant technical constraints created by the Narrative are contained in Sections 2 through 7.

The two steps were:

A. ***Development of a subsection summary*** based on the subsection data was then undertaken. The analyst considered each CONOPS entry and determined what the "Derived Requirements" were for each of the functions with the focus on what may be missing. The analyst recorded a brief description of all potential Gaps. These potential Gap statements were accompanied by a list of CONOPS entries from which it was derived. These results are found in the CD-ROM version of this document in Appendix F.

B. ***Development of the Section summaries*** was the next step. The collection of subsection summaries was assembled by section in a list as in the example in Figure 5. These results are found in the CD-ROM version of this document in Appendix F



Sec 4 Departure and Arrival Services

Overall Chapter Assessments

Section	Coverage Comment	Gap
COMMUNICATIONS		
Sec 4	The transition to automation for NAS-WIS lacks addressing.	X
Sec 4.1	comm programs adequate	
Sec 4.2.1	comm programs adequate	
Sec 4.2.2	The transition to automation for NAS-WIS lacks addressing. A system needs to developed that will capture user input information as operational	X
Sec 4.2.3	comm programs adequate	
Sec 4.2.4	Advanced coordination of planned departure routes is not explicitly mentioned.	X
Gap	The transition to automation for NAS-WIS lacks addressing. Advanced coordination of planned departure routes is not explicitly mentioned. A system needs to developed that will capture user input information as operational requirements.	
NAVIGATION		
Sec 4	nav programs adequate	
Sec 4	ded to develop rules, procedures, and training f	

Figure 5 Communications Summary for Section 4, "Departure and Landing Services"

The analyst, with this information conveniently organized by functions, filled in the "Gap" row. The collection of all of the Gaps for a Section was assembled into a list.

The collection of the gaps from Sections 2 through 7 is combined into one summary sheet.

Step 8. Subject Matter Expert Evaluation:

The subject matter experts provided an independent identification of the Gaps by use of key-word searches. The approach consisted of selecting key words from each CONOPS entry and searching the set of program documents for matches. The collection of matches was then examined to determine if entries were not being addressed. A list of gaps was developed from this analysis.

The subject matter experts then reviewed the Gaps identified from Phase I and produced a combined list.

Step 9. Revised List of Gaps: The judgements from step 8 were assembled into a single list of Gaps.

Step 10. Final List of Gaps: The list completed in step 9 was then examined in detail using an indexed search of an extended set of documents to identify all references to relevant material. The result of this examination is a final list of Gaps, which is found in Section 4 , CONCLUSIONS.

2.2 DATA COLLECTION

The goal of data collection was to assemble program descriptions from as many cooperative sources as possible. A summary of the sources for this data collection effort is in Table 5.

Table 5 Data Sources

Organization	*Source Item*
FAA	***Aviation System Capital Investment Plan*** – January 1999
FAA	Research Program Descriptions (RPD's) - FY2000
Lincoln Laboratories	Relevant aviation-related research programs at Lincoln Laboratories (source-provided)
MITRE	***CAASD FY 99 Product Based Work Plan***
NASA AATT	NASA AATT portion of ***NASA Aviation System Capacity Program***
NASA TAP	NASA TAP portion of ***NASA Aviation System Capacity Program***
NCAR	Relevant aviation-related research programs at the National Center for Atmospheric Research (source-provided)
Nextor	National Center of Excellence for Aviation Operations Research: Research Programs
NOAA	Relevant aviation-related research programs at the National Oceanic and Atmospheric Administration (source-provided)
FAA	***National Airspace System Architecture – Version 4.0***
RTCA	***SafeFlight21 Master Plan***
Eurocontrol	Analysis of Research and Development in Eurocontrol Programmes (ARDEP): Air Traffic Management Research and Development Project Synopses - 1998

The complete list of programs is in Appendix A (including hyperlinks to the programs in CD-ROM version of the report).

3 ANALYSIS RESULTS

3.1 RESEARCH AND DEVELOPMENT OVERLAPS

The detailed review of the Narrative, the associated Level I CONOPS entries, and the related program descriptions in this study identified no duplication of effort. Although some programs studied the same technology areas, the programs were not found to duplicate each other's work.

3.2 LIST OF RESEARCH AND DEVELOPMENT GAPS

This list is a compilation of the detailed analysis performed in Phase I, the review by subject matter experts in Phase II, and the final review in Phase III. A Gap in this study is defined as a technology that is both derived from the Narrative Level I CONOPS entries and is not mentioned in any one of the documents studied in Phase I (see Table 5). For example, if a technology is mentioned only in the FAA Architecture 4.0 it will still be a Gap unless there is a research program or a CIP program associated with it.

Listed below are concepts from the CONOPS entries that were not addressed by the research and development examined by this study. Each gap statement is accompanied by the functions and CONOPS entries affected by the gap. Also, the list has been divided into two priority groups, based on the number of CONOPS entries affected by the gap. Group A gaps affect three or more CONOPS entries, while group B gaps affect one or two CONOPS entries.

Table 6 Gap List – Group A

Gap Analysis - Group A			
Gap ID	**Gap Statement**	**Catego-rization**	**Affected CONOPS Entries**
A-1	The NAS-Wide Information System (NAS-WIS) will satisfy many of the information distribution concepts in the Narrative, and will interface with many systems. A plan for creating and implementing the protocols and hardware for this interface is necessary. This plan is not addressed by the programs.	CA	Flight Planning: 2.2, 2.7, 2.12, 2.16, 2.21 Surface: 3.5, 3.8, 3.9, 3.10, 3.15, 3.24, 3.25, 3.33, 3.37, 3.45 Dep/Arr: 4.7, 4.54 En Route: 5.39, 5.41, 5.43, 5.61 Nas Mgmt: 7.28, 7.43, 7.44, 7.46, 7.51, 7.53, 7.64, 7.73
A-2	The availability of information for the cockpit is much expanded, as described in the Narrative. A decision support tool (DST) is needed to determine which data is important to each flight, so the appropriate information can be datalinked to the flight. This DST is not addressed by the programs.	CAM	Flight Planning: 2.1, 2.2, 2.7, 2.12, 2.16, 2.17

A-3	A Flight Planner Display is required to satisfy flight planning concepts from the Narrative. This Flight Planner Display requirement is not addressed by the programs.	CA	Flight Planning: 2.9, 2.10, 2.11, 2.12, 2.13, 2.14, 2.15, 2.17
A-4	In the Narrative surface environment, surface movement decision support tools (DST's) contribute data to the NAS-Wide Information System (NAS-WIS), as well as retrieving data from it. Integration of surface movement DST's into the NAS-WIS is not addressed by the programs.	CA	Surface: 3.7, 3.8, 3.9, 3.10, 3.12, 3.26
A-5	In the Narrative terminal environment, separation assurance can be shared between the cockpit and ground. The rules, procedures, and training for shared separation assurance need definition. Shared separation assurance protocols are not addressed by the programs.	NSA	Dep/Arr: 4.12, 4.21, 4.23, 4.24, 4.25
A-6	Weather data will be widely available to decision support tools (DST's) via the NAS-Wide Information System (NAS-WIS). In order to take advantage of this weather information availability, widespread integration of weather data with DST's and the NAS-WIS is necessary. This weather integration is not addressed by the programs.	WA	Dep/Arr: 4.20, 4.27, 4.35, 4.36, 4.49, 4.52, 4.53
A-7	When demand and capacity imbalances occur, temporary structured routes are created to handle the problem. These temporary routes are formed using a gridded En Route structure. Systems and procedures for creating, and then using this gridded En Route structure are not addressed by the programs.	A	En Route: 5.6.2, 5.22, 5.23
A-8	In the Narrative environment, the current route structure is replaced with a global grid of named locations. This global grid and the automation necessary to establish routes through it are not addressed by the programs.	A	En Route: 5.20, 5.22 Oceanic: 6.9
A-9	The environment described by the Narrative includes a high level of international coordination/collaboration. The international communications structure and protocols necessary for this coordination/collaboration are not addressed by the programs.	CA	Oceanic: 6.16, 6.17, 6.38, 6.40 Nas Mgmt: 7.29
A-10	Improved oceanic weather information is available in the environment described by the Narrative. Oceanic weather detection and integration into automation is not addressed by the programs.	WA	Oceanic: 6.34, 6.36, 6.37, 6.40
A-11	In the Narrative environment, "traffic management initiatives" are set up by service providers to assist in flow management. "Traffic management initiatives" are not addressed by the programs.	A	Surface: 3.10, 3.25 Dep/Arr: 4.57 Nas Mgmt: 7.7, 7.51

Table 7 Gap List – group B

Gap Analysis - Group B			
Gap ID	**Gap Statement**	**Categorization**	**Affected CONOPS Entries**
B-1	Improved emergency locator transmitters (ELT's), along with corresponding new standards and rule making, are part of the NAS search and rescue environment described in the Narrative. The creation of improved ELT's is not addressed by the programs.	CA	Flight Planning: 2.20
B-2	For search and rescue, emergency locator transmitters (ELT's) must downlink the aircraft's last known position to the NAS-Wide Information System (NAS-WIS). This ELT downlink is not addressed by the programs.	CA	Flight Planning: 2.21
B-3	When aircraft are overdue and no emergency locator transmitter (ELT) signal is detected, the flight's information needs to be readily available for search and rescue organizations through the NAS-Wide Information System (NAS-WIS). The availability of this information to search and rescue is not addressed by the programs.	CA	Flight Planning: 2.22
B-4	In the Narrative, data flows seamlessly throughout an airport. Integration of data to/from service provider, flight deck, AOC, ramp, airport operator, & airport emergency centers is necessary. This intra-airport data integration is not addressed by the programs.	CA	Surface: 3.23, 3.24
B-5	The status of aircraft on the airport surface is closely monitored in the Narrative environment. Automation is necessary that updates any changes in taxiing aircraft regarding taxiway routes, gate assignments, desired runways, etc. This surface movement status automation is not addressed by the programs.	A	Surface: 3.37
B-6	In the Narrative, surface management tools assist users in finding the most optimized surface route for aircraft. These tools include, as input, aircraft intent. The inclusion of aircraft intent to surface management tools is not addressed by the programs.	A	Surface: 3.40
B-7	In the Narrative, many factors affect surface movement management, including deicing procedures. The inclusion of deicing requirements in surface movement management is not addressed by the programs.	A	Surface:3.44

B-8	In the Narrative environment, the surface management information system provides intra-airport connectivity. However, when this is not available, *ad hoc* adaptations of the NAS-WIS will provide basic connectivity. These NAS-WIS adaptations for surface information are not addressed by the programs.	M	Surface: 3.27
B-9	Increased use of decision support tools (DST's) occurs in the environment described by the Narrative. Service providers will provide parameters for DST's, and the DST's will develop the plans to manage airspace. The creation of DST's that can take parameters as input, and create plans as output is not addressed by the programs.	A	Dep/Arr: 4.48
B-10	An aircraft's intended route is tracked via a flight profile. Automated support for adherence to its selected profile is necessary. This adherence-checking automation is not addressed by the programs.	SA	Dep/Arr: 4.66
B-11	In the Narrative environment during pre-flight, advanced coordination of planned departure routes is performed. This advanced departure coordination is not addressed by the programs.	CA	Dep/Arr: 4.68
B-12	Aircraft self-separation is more common in the Narrative environment than today, because advancements to TCAS and FMS automation integration allow self-separation assurance (i.e. station keeping/spacing). These TCAS and FMS advancements are not addressed by the programs.	NSA	Dep/Arr: 4.45
B-13	User input concerning flow constraints will be solicited, and entered into the NAS-Wide Information System (NAS-WIS) as operational requirements. The obtaining and distribution of user input information is not addressed by the programs	CAM	Dep/Arr: 4.58
B-14	In the environment of the Narrative, changes in the airspace and route structures are continually updated to the NAS-Wide Information System. The systems and interfaces necessary to perform this continual updating are not addressed by the programs.	CA	En Route: 5.8
B-15	In the Narrative environment, separation standards depend on the flight's equipage and the quality of the positional data. Separation standards based on the quality of position data must be established. These standards are not addressed by the programs.	SA	En Route: 5.18
B-16	In the Narrative environment, separation standards depend on the flight's equipage and the quality of the positional data. Separation standards based on flight equipage must be established. These standards are not addressed by the programs.	A	En Route: 5.18

B-17	Expanded weather information is available to the pilot. A pilot will be able to obtain weather forecasts for not only the specific areas through which the aircraft will pass, but the specific time at which the aircraft will pass through that area. This time-based weather forecasting system is not addressed by the programs.	WA	En Route: 5.26
B-18	Improved Visual Flight Rules (VFR) flight following services are a part of the Narrative environment. The definition and implementation of improved VFR flight following services are not addressed by the programs.	A	En Route: 5.40
B-19	In the Narrative environment, aircraft flying under Visual Flight Rules (VFR) conditions automatically report their satellite-derived positions. The automatic reporting of positions by VFR aircraft is not addressed by the programs.	SA	En Route: 5.41
B-20	In the Narrative environment, if a Special-Use Airspace (SUA) is activated, all flight trajectories passing through that SUA are re-evaluated. This re-evaluation of flight trajectories based on SUA activation is not addressed by the programs.	A	En Route: 5.43
B-21	The traffic flow service provider has the same tools as those providing separation assurance, as stated in the Narrative. The providing of separation assurance tools to the traffic flow service provider is not addressed by the programs.	SA	En Route 5.57, 5.58
B-22	In the Narrative environment, aircraft-to-aircraft conflict detection tools are also used for aircraft-to-airspace (Special Use Airspace). This application of aircraft-to-aircraft conflict detection tools to aircraft-to-airspace conflict situations is not addressed by the programs. However, the more general issue of aircraft-to-airspace separation is addressed by the Conflict Probe.	A	En Route: 5.45
B-23	In the oceanic airspace environment of the Narrative, electronic message routing exists for the oceanic domain. Oceanic electronic message routing is not addressed by the programs.	CA	Oceanic: 6.14
B-24	The oceanic environment envisioned by the Narrative included international data connectivity. Data must be in a standard format, so that all oceanic service providers can receive it. The establishment of this common format is not addressed by the programs.	A	Oceanic: 6.10
B-25	In the oceanic environment of the Narrative, aircraft violating Air Defense Boundaries are automatically reported to the military. The connecting of the military into the oceanic communications system to allow this automatic reporting is not addressed by the programs.	CSA	Oceanic: 6.30

B-26	As described in the Narrative, the oceanic airspace structure may change dynamically, based on weather, demand, and user preferences. This flexible oceanic airspace structure is not addressed by the programs.	A	Oceanic: 6.34, 6.35
B-27	NAS Oceanic Airspace is standardized with ICAO. This ICAO standardization is not addressed by the programs	A	Oceanic: 6.10
B-28	Real-time oceanic communications can apply satellite communications links. Oceanic satellite communications is not addressed by the programs.	C	Oceanic: 6.33
B-29	International service providers have the ability to communicate easily with other international service providers. International communication standards establishment is not addressed by the programs.	CM	Oceanic: 6.17
B-30	In the user-friendly environment described in the Narrative, infrastructure management takes into account the input of infrastructure users. Collaboration with the user for infrastructure management is not addressed by the programs.	CA	Nas Mgmt: 7.22
B-31	In the Narrative environment, automated information exchange among domestic/international service providers allows seamless global air traffic management. A seamless global air traffic management system is not addressed by the programs.	AM	Nas Mgmt: 7.10
B-32	As described in the Narrative, air traffic service providers have access to infrastructure trouble report status. Infrastructure trouble reports are not addressed by the programs.	A	Nas Mgmt: 7.39, 7.40
B-33	To achieve the global traffic flow management envisioned in the Narrative, broader information on international traffic and aviation equipment is necessary. The availability and handling of broader international equipment information is not addressed by the programs.	CAM	Nas Mgmt: 7.45
B-34	In the environment of the Narrative, the ATCSCC service providers can improved NAS service by managing national programs that modify national procedures. The establishment of these national programs to determine national procedures is not addressed by the programs.	M	Nas Mgmt: 7.50
B-35	The international air traffic environment described by the Narrative includes obtaining more comprehensive and current information from international service providers. This obtaining of international traffic information is not addressed by the programs.	CA	Nas Mgmt: 7.57

B-36	In the Narrative environment, the ATCSCC service providers have comprehensive information for situation awareness. The information includes receiving cancellations and push back data. This reception of cancellation and push back data is not addressed by the programs.	CAM	Nas Mgmt: 7.58
B-37	NAS information is automatically recorded, as described in the Narrative. The information includes arrival capacity allocations, reroute programs, and other restrictions. NAS information recording is not covered by the programs.	CA	Nas Mgmt: 7.60
B-38	In the Narrative environment, the ATCSCC service providers may use capacity control programs (CCP's) to manage traffic, primarily during infrastructure outages or inclement weather. These CCP's are not addressed by the programs.	A	Nas Mgmt: 7.66, 7.68
B-39	In the Narrative environment, flow constraints are distributed equitably among users. The process used to assess the fairness of flow constraints is not addressed by the programs.	A	Nas Mgmt: 7.72
B-40	A "prioritization scheme" is used for system management activities, as described in the Narrative. This prioritization scheme is not addressed by the programs.	AM	Nas Mgmt: 7.76
B-41	The Narrative environment includes a point-of-contact system for infrastructure management. This infrastructure management point of contact system is not addressed by the programs.	M	Nas Mgmt: 7.39

3.3 KEY TECHNOLOGY AREA PROGRAMS

Six technology areas have been identified as key to accomplishing the vision of the Narrative. They are key because they are essential in satisfying a large proportion of the Narrative Level I CONOPS entries and they entail significant research, development, and implementation efforts. A graph showing these proportions is in Figure 6. The Summaries found in Appendix A and the associated RPDs (on the CD-ROM version of this document) provide the details.

The six key technology area programs are:

1. NAS-Wide Information System (NIS): This technology area is identified to supply a dominant portion of the communications needs. The collection of products and may be provided through several separate programs rather than the one NIS program.

2. Automatic Dependant Surveillance - Broadcast (ADS-B): This technology has been under study for over 15 years and is identified as a solution to surveillance coverage, accuracy, and integrity needs for domestic (continental United States), oceanic, and world wide airspace.

3. Data Link: This technology is generally defined as two-way digital communications from the ground to an aircraft. The difference between this technology and NIS is

that Data Link focuses on the content and use of this one feature. Numerous studies over the last 20 years have identified a central role for data link in transferring information to and from the aircraft with very high accuracy and integrity.

4. National Infrastructure Management System (NIMS): The NIMS directly affects 16% of the Narrative Level I CONOPS entries in the general area of National Airspace System (NAS) Management (Section 7 of the Narrative) and other sections of the Narrative for which infrastructure management requirements are derived.

5. GPS and Augmentation (WAAS & LAAS): The GPS has been a concentrated area of study for the FAA since the first satellites were launched. The augmentation programs have been identified and contracts awarded to provide the needed precision and integrity to support civil aviation navigation requirements.

6. Safe Flight 21: Safe Flight 21 consists of the demonstration of nine specific technologies that are critical to the concept of free flight. These nine technologies are individually and collectively needed to address over 64% of the Narrative Level I CONOPS entries. The nine technology areas are:

   - Flight Information Service (FIS)
   - Controlled Flight Into Terrain (CFIT)
   - Improved Terminal Operations in Low Visibility
   - Enhanced Visual Operations and Situational Awareness
   - Enhanced Operations for En Route Air-to-Air
   - Improved Surface/Approach Operations
   - Airport Surface Display for the Controller
   - ADS-B for Surveillance in Non-Radar Airspace
   - ADS-B to Enhance Radar and Automation Performance

The proportion of the 325 Narrative Level I CONOPS entries directly affected by each of these technologies in graphically displayed in Figure 6.

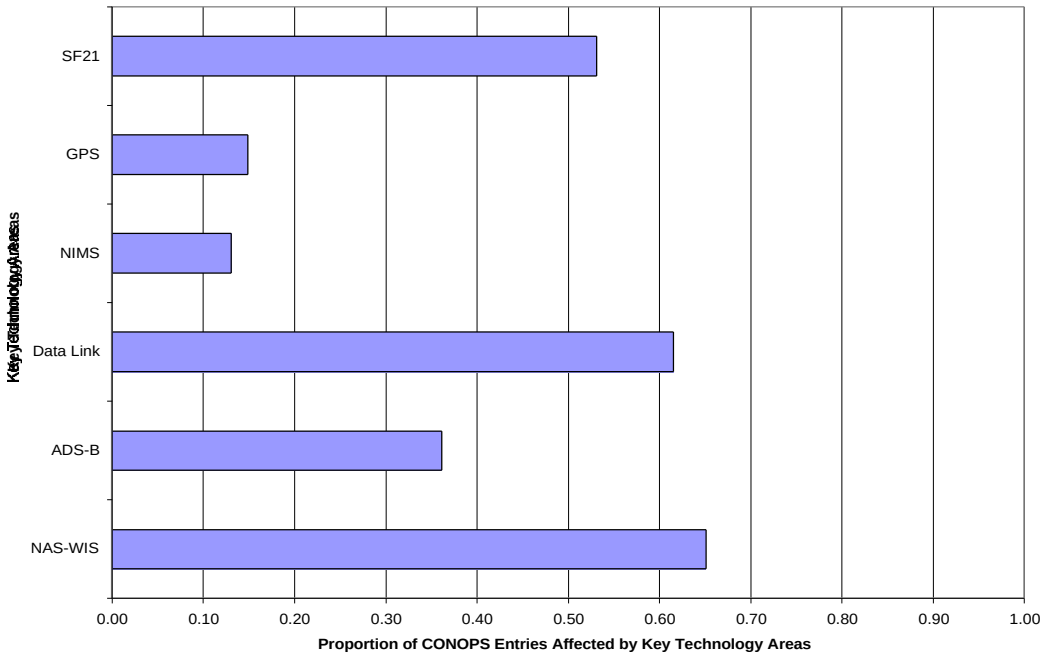


Figure 6 Key Technology Programs

3.4 CUMMULATIVE AND STATISTICAL SUMMARIES

3.4.1 OVERALL COVERAGE HISTOGRAMS

The number of programs contributing to a Narrative Section (Domain) shown in 0 is based on the categorizations of the programs. The categorization information is contained on the Summaries of the programs (Appendix A). The program list includes all of those used in the Phase I analysis as is shown in Table 5 and listed in Appendix A.

Similarly, the number of programs contributing to NAS Functions is shown in Figure 8. This data is also based on the categorizations of the programs.

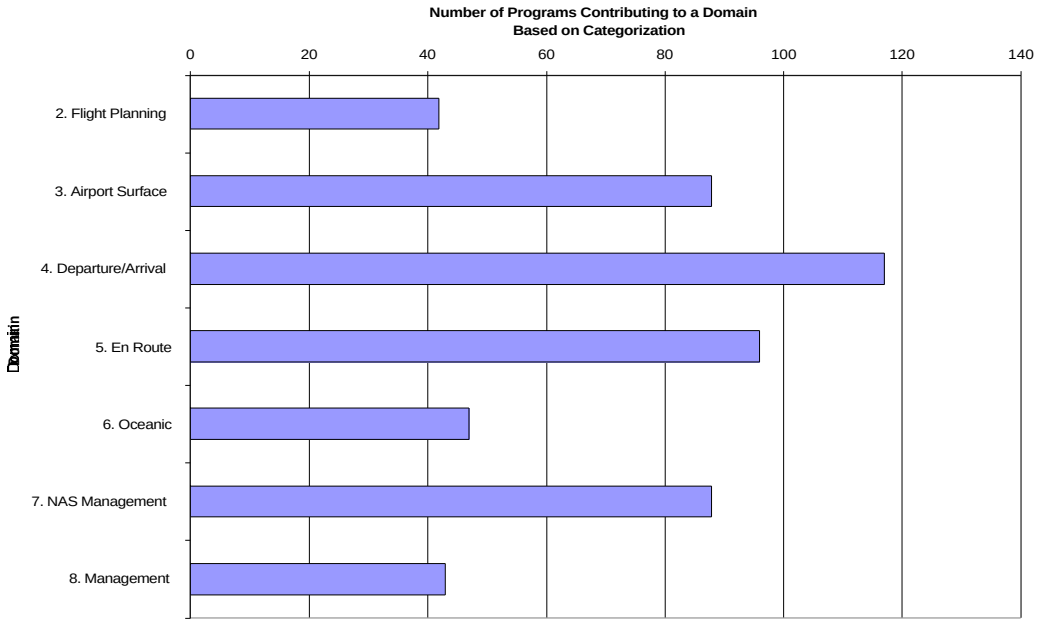


Figure 7 Number of Programs per Narrative Section

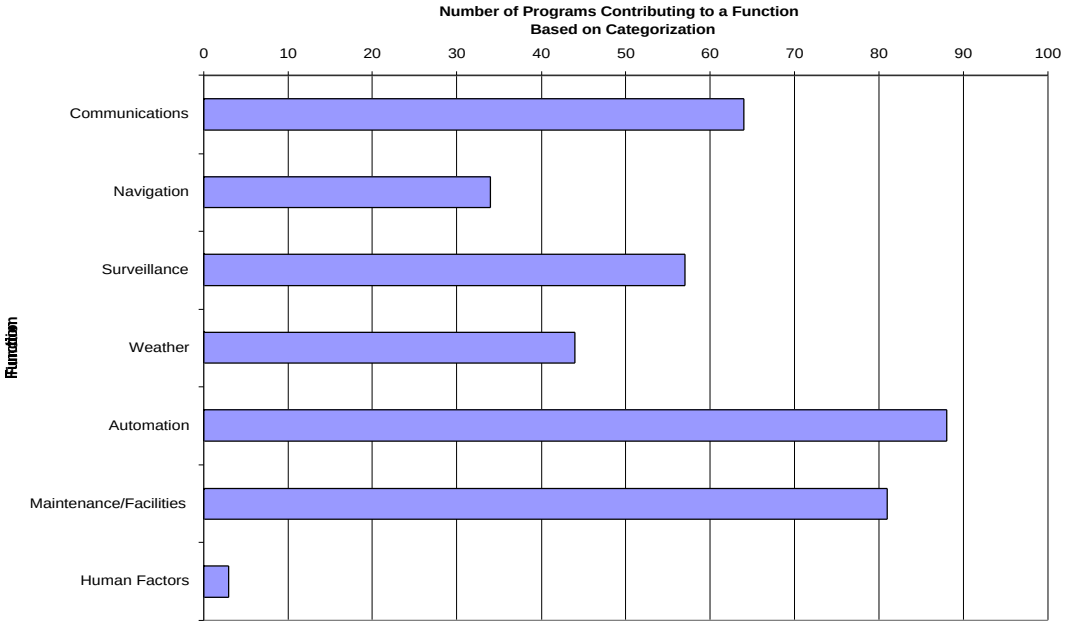


Figure 8 Number of Programs per Function

3.4.2 MAPPINGS SUMMARIZED BY NARRATIVE SECTION

The bar graphs in this section provide more detailed information regarding the number of programs that are applicable to each CONOPS entry. Each graph contains the results for the CONOPS entries from a different section. In this way, specific Level I CONOPS entries can be identified that are supported by a small number of programs.

Although these histograms do not disclose specific Gaps or weakness in work, they do provide a useful reference when assessing the program coverage for an area or CONOPS entry. The data from which these graphs were created are contained in Appendix F.

These charts indicate the great extent to which both the content of the Narrative and the identified functions are being addressed.